MICHIGAN

# State of the Great Lakes

## 2021 REPORT

EGLE

MICHIGAN DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY

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*Prepared by the Michigan Department of Environment, Great Lakes, and Energy on behalf of the Office of the Governor (January 2022)*


*Cover photo: A water scene from the Dead River, downstream of the Forestville Dam, in Marquette, Mich. (Photo courtesy of the Michigan Department of Natural Resources)*

# Historic investments in Michigan's water infrastructure to benefit state – from source to tap

*Michigan's investment in water infrastructure in 2021 will pay dividends for decades to come*

This year marked the roll-out of a historic investment to rebuild Michigan's water infrastructure while creating thousands of good-paying jobs in the process.

Last October, I announced the MI Clean Water plan with bipartisan and bicameral partners. It's a $500 million comprehensive investment in Michigan's water system – from source to tap – and marks a significant investment after decades of underinvestment in infrastructure. So much of the plan involves and relates to the Great Lakes – the source of drinking water for more than half of Michigan's residents and home to 21% of the world's freshwater. These investments will help communities across the state constrained by local budgets safeguard residents' health and take action to protect the Great Lakes.

To marshal resources, the MI Clean Water plan is taking a unified approach to cleaner, more affordable water. This provides direct investments for communities, helps provide safe, clean water to residents and will support over an estimated 7,500 Michigan jobs, according to the U.S. Environmental Protection Agency.

As Michigan's economy continues to recover from the pandemic, the MI Clean Water plan will benefit communities in every corner of Michigan by creating jobs, protecting public health and improving environmental quality. The plan addresses urgent infrastructure issues including undersized sewers, failing septic systems, unaffordable water rates and protection from lead, per- and polyfluoroalkyl substances (PFAS) and other contaminants that can affect drinking water.

Nearly $1 billion in infrastructure grants and low-interest loans have been authorized to Michigan communities in 2021, marking an almost six-fold increase in funding since 2018 from the State Revolving Fund, which assists communities by financing infrastructure improvements to their drinking water, storm water and wastewater systems.

I've also proposed a $200 million expansion of the MI Clean Water plan to remove lead service lines across the state and called on the Legislature to use federal funds from the American Rescue Plan to improve access to safe drinking water. I am committed to using every federal, state and local resource available to support these efforts.

The MI Clean Water plan is a critical step toward ensuring all Michiganders have access to clean, affordable drinking water and healthy surface water and groundwater. These strategic investments in Michigan's infrastructure will help families and communities thrive, uplift the economy and protect the Great Lakes.

Thank you,

Governor Gretchen Whitmer



# Michigan is implementing solutions for infrastructure, climate challenges

*Adaptation, mitigation, and resiliency strategies will save taxpayer dollars in the long run*

Recent wet weather and high-water levels have given communities a sobering taste of the challenges we face in an age of climate-linked extreme weather. Driven by more frequent intense storms, all that water has put lives at risk, caused major property damage and left local governments and Michigan residents with massive repair bills.

Climate change and water events have laid bare Michigan's underinvestment in infrastructure. It was evident in the dam failure in Edenville and Sanford and as we watched high water encroach on private property and public infrastructure, crumbling away roads and homes in its path. This summer's storms overwhelmed under-built systems that couldn't keep up, flooding roads and basements and sending sewage into waterways and ultimately into the Great Lakes.

This year's State of the Great Lakes report focuses on the activities and programs that are implementing solutions for the problems Michigan is facing. It is vital that we respond to current issues and get ahead of challenges that promise to grow without action on our part. From resilient communities to sustainable water use and groundwater challenges, the report emphasizes the interconnectivity of Michigan's waters.

The year 2021 marked a turning point when it comes to investment into our water infrastructure, advancing progress to decarbonize our economy and increase the resiliency of our state.

- The money proposed in Governor Whitmer's historic $500 million MI Clean Water plan for drinking water infrastructure is moving to communities now.
- The Council on Climate Solutions is working on implementation of the MI Healthy Climate plan to create a roadmap to 100% decarbonization by 2050.
- EGLE's Catalyst Communities program is providing training and technical assistance to local leaders who will chart climate resilient paths forward.
- The Michigan Coastal Management Program launched its Coastal Leadership Academy to bring together community leaders and planners to address coastal resilience challenges.

Investments in climate change adaptation, mitigation, and resiliency strategies will save taxpayer dollars in the long run. According to the National Institute of Building Sciences, for every $1 invested in federal mitigation grants, taxpayers can save $6.

All of this investment is being done with overburdened and low-income communities in mind. Wise climate solutions can advance equity and environmental justice across Michigan communities. Michigan's march to decarbonize over the next three decades can make the Great Lakes State a better state. The time is right to rebuild Michigan's infrastructure to address current challenges and provide a strong base for our economic growth moving forward. With an eye toward protecting Michiganders' health and environment, EGLE's 1,300 staffers who work alongside me are carrying out that mission – from groundwater, to surface waters, to the Great Lakes.

Liesl Eichler Clark
Director, Michigan Department of Environment, Great Lakes, and Energy

# Understanding groundwater quantity and quality key to better management

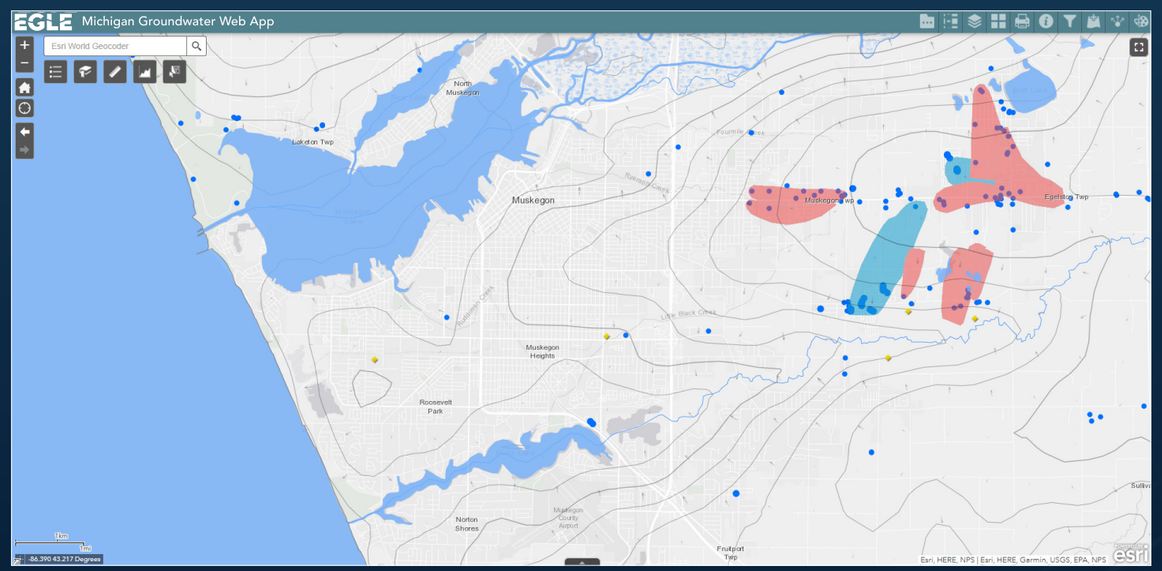
*Mapping project underway to provide framework for State*

*By Teresa Seidel, director, Michigan Department of Environment, Great Lakes, and Energy's Water Resources Division*

The Great Lakes went from some of the lowest water levels in history in 2013 to record high water levels in 2019-2020. The connection between the Great Lakes and groundwater caused groundwater tables to rise in much of the state, leading to inland flooding. However, at the same time, data from some water management areas, especially in the southwest part of Michigan, have shown depleted groundwater resources. The perplexing nature of these high and low water levels at the same time challenged those working in the groundwater arena to understand what is happening to this resource.

Researchers, regulators, groundwater users and environmental organizations are all looking to answer questions about what we really know about Michigan's groundwater quantity and quality. The intersection of everyone's interest is helping to bring attention to the need to better understand and manage Michigan's groundwater.

Groundwater intersects nearly every program within the Department of Environment, Great Lakes, and Energy (EGLE). The focus tends to shift depending on the program needs and regulatory authority. Much emphasis has also been placed on the Water Use Program through the Water Use Advisory Council (WUAC). The WUAC's report to the Legislature in 2020 identifies findings and recommendations related to water quantity. Funding to implement the recommendations is with the Legislature for consideration.




*Prototype of EGLE Michigan Groundwater App. Location: Southwest Muskegon County. Yellow diamonds indicate Superfund National Program List Sites; Blue circles are Type 1 & 2 wells; Blue shaded areas are Type 1 Provisional Wellhead Protection Areas; Red shaded areas indicate Type 2 Provisional Wellhead Protection Areas; Gray contour lines indicate preliminary regional groundwater elevations contours in the upper glacial drift aquifer (Contour interval is 10 feet.); and gray arrows indicate the general groundwater flow direction. (Figure courtesy of EGLE)*

This past year, EGLE has begun to coordinate and collaborate across divisions to understand what we already know about groundwater quality and quantity and what data gaps exist. As part of this effort, EGLE has begun a mapping project of existing groundwater data from our databases within the department. This is the first step in moving to a more complete compilation of the department's groundwater data in a visual format to gain a greater understanding of Michigan's groundwater resources.

Presently, data related to groundwater exists in many locations but is not shared or accessible outside of the location where it is housed. Mapping the groundwater and understanding the hydrogeology of the state are critical to understanding the resource. Many efforts by many partners are ongoing to ensure consistent data collection, create a space for data to be stored and shared and identify where data gaps exist. Mapping is an important component for the development of the comprehensive and collaborative creation of a groundwater framework for the state of Michigan.

More recently, groundwater has been also gaining more attention around the state and at a regional scale. In 2021, several groundwater projects got underway that EGLE is participating in. They are providing forums for information sharing, identifying gaps in knowledge and science and understanding approaches to groundwater regulations and governance across the Great Lakes region. These projects are highlighted below:

For Love of Water (FLOW), a regional water policy non-profit, is hosting a Groundwater Table comprised of groundwater experts across disciplines, including EGLE's experts. The Groundwater Table meets every other month, highlighting different topics and issues related to groundwater.

The Cooperative Institute for Great Lakes Research (CIGLR) sponsored a Groundwater Summit in June 2021. CIGLR invited experts from the academic, private and public sectors. Summit attendees worked toward the overall goals of (1) creating an inventory of the key challenges facing groundwater in Michigan; (2) identifying the knowledge gaps and scientific needs, as well as policy recommendations, associated with these challenges; (3) constructing a set of conceptual models and (4) developing a list of next steps that can be taken to address these challenges.

A team of researchers and facilitators from Freshwater, the University of Minnesota Humphrey School and Water365, a Milwaukee-based firm, is leading a study titled: "Groundwater Governance in the Great Lakes Region: A Comparative Study with Engagement," funded by The Joyce Foundation. The project is comparing approaches to regulating and protecting groundwater in the Great Lakes states of Minnesota, Wisconsin, Michigan, Illinois, Indiana and Ohio and tribal governments in those areas. This project looks at dependence on the resource for drinking water, industry or irrigation and how this dependence factors into the economy of an area, recognition of the ecosystem services of groundwater and the more difficult to quantify cultural or spiritual value placed on water.

All of these state and regional efforts underway will collectively help contribute toward a greater understanding of groundwater science in Michigan and the region. By improving our understanding about quantity and quality of the groundwater resource, decisions regarding its use can also become more transparent. Together, these efforts help to raise awareness about the value and importance of and need for stewarding groundwater resources in the state and the region. ◆

# WATER USE ADVISORY COUNCIL REPORT MAKES RECOMMENDATIONS

***Council uses consensus-based approach to advance water use program***

*By Jim Milne, Michigan Department of Environment, Great Lakes, and Energy*

Michigan's Water Use Program is a science-based program that relies on a wide variety of data to help sustainably manage Michigan's surface water and groundwater resources to protect stream flow and fish populations.

The program includes the Great Lakes Compact, water withdrawal regulations, and water use conflict. To help improve the program, an external stakeholder group called the Water Use Advisory Council (WUAC) was established under Part 328, Aquifer Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, to study and make recommendations to the Quality of Life (QOL) agencies (Department of Environment, Great Lakes, and Energy, Department of Natural Resources and Michigan Department of Agriculture and Rural Development) and the Legislature. The WUAC collaboratively studies, evaluates and provides advice regarding Michigan's water management, conservation and efficiency programs. It also assists the agencies on technical issues, implementation and monitoring overall progress of Michigan's Water Use Program.

The WUAC provides a forum for dialogue and discussion of the following broad areas identified by five previous councils, stakeholder groups and state agencies:

- Water conservation and efficiency goals, objectives and voluntary measures.
- Technical underpinnings of the process, tools, data, assumptions and decision endpoints used to determine whether proposed water withdrawals can be authorized.
- Technical and compliance assistance.
- Methods and tools to assist water users in resolving and preventing conflicts.
- Environmental monitoring to identify and help reconcile potential discrepancies between the program's decision-making and data management protocols and the real-world impacts of withdrawals.
- New and emerging water use categories.
- Outcomes and metrics for determining the program's success.

*(Above) Stream at Largo Springs near Oscoda, Mich. (Photo courtesy of Sara J. Gross)*



The WUAC released its first biennial report to the Legislature in December 2020. The WUAC's recommendations, reached by unanimous consensus, will advance and improve conservation, data collection, modeling, research, refinement and administration of the water withdrawal assessment process. They will also benefit many other state water management issues.

A few priority recommendations include:

- **Improving water conservation and efficiency**, including an assessment of climate, energy, sustainability and water infrastructure policies to identify gaps and opportunities. Also recommended is the establishment of an education program for agricultural water use efficiency.
- **Creating a Michigan Integrated Water Management database** to make data available in an accessible geospatial format.
- **Training well drillers to improve the accuracy of their geologic descriptions in water well logs**, a key source of information about Michigan's glacial and bedrock geology.
- **Creating the Michigan Hydrologic Framework** that provides access to hydrologic data, comprehensive hydrologic analysis, and other models to help create groundwater/surface water models to improve water management decision-making.
- **Collecting geologic data and mapping for up to 25 targeted areas in Michigan.**
- **Installing monitoring wells and joining the National Groundwater Monitoring Network.**
- **Identifying critical data gaps and prioritizing data collection** by analyzing streamflow, groundwater and geologic data.
- **Improving the Water Withdrawal Assessment Tool** to display large quantity water withdrawal registration information in addition to the streamflow depletion status of sub-watersheds affected by the proposed withdrawal.
- **Updating the statewide aquifer property estimates** to reflect geologic conditions more accurately.
- **Mapping the glacial geology in Calhoun and Cass Counties** in three dimensions.
- **Developing a user manual to help form water user committees** to manage water resources at the local level.

*"The Water Use Program is based in science and is only successful if supported by adequate data, advancements in modeling and adoption of new technologies, practices and conservation measures."*

*– WUAC 2020 Report to the Legislature*

*Ross Helmer, EGLE, taking a stream flow measurement in the Pokagon Creek near Pokagon, Mich. (Photo courtesy of EGLE)*

These recommendations will help Michigan continue to invest in sustainable water use and meet its obligations under the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement and the Great Lakes-St. Lawrence River Basin Water Resources Compact. In all, the recommendations include funding requests to the Legislature totaling $5.2 million in fiscal year 2022 and $4.9 million in fiscal year 2023.

The WUAC, established by Michigan law, is made up of 23 diverse, external stakeholders and representation from Michigan's federally recognized tribal governments.

The full report contains more details about the WUAC's recommendations. ◆

# Long-term risk groundwater economic study: exploring the costs of institutional controls

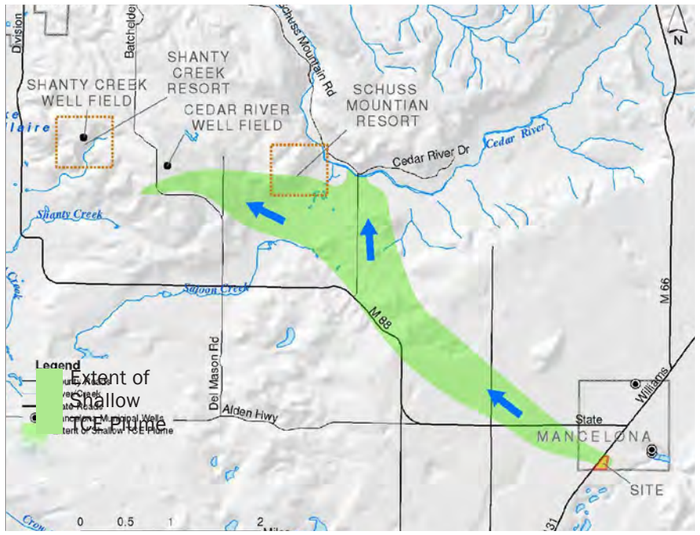
***Study will determine economic impact of contamination remedies***

*By Jeremiah Asher, Michigan State University, Institute for Water Research*

Balancing the need for sustainable economic development with protection of Michigan's vital groundwater resources is an important public policy question. With funding from the Department of Environment, Great Lakes, and Energy's (EGLE) Office of the Great Lakes, Michigan State University's Institute for Water Research (MSU-IWR), MSU Extension's Center for Economic Analysis (MSUE-CEA) and the nonprofit group FLOW (For Love of Water) have started a study to determine the economic impact of remedies for groundwater contamination that limit human exposure rather than removing all contaminants.

Under state policies in place since 1995, when a liable party or EGLE is faced with the decision on how to select an appropriate remedy for contaminated groundwater, they may rely on institutional controls (ICs). These can provide an easier and, at least initially, more affordable response than approaches such as extraction and treatment of contaminated groundwater. These ICs are usually either deed restrictions or municipal ordinances. They are often used for brownfield redevelopment, an important priority for communities.

But leaving the contamination in place and simply restricting access to the affected groundwater can have long-term impacts that are difficult to account for and have been overlooked at times in the initial remedy selection process. These impacts may include lost opportunities for future development when access to groundwater is restricted, decreased real estate values and unanticipated human health or environmental risks.




*Wickes Manufacturing TCE groundwater plume, Antrim County. (Image courtesy of EGLE)*

With funding from EGLE, researchers from MSU-IWR, MSUE-CEA and FLOW will study the long-term costs of implementing institutional controls as a groundwater contamination response in Michigan.

The study will identify eight to 12 case sites in which an IC for groundwater was used in Michigan and calculate the cumulative cost of that choice at each site, including costs associated with monitoring, wildlife impacts, property value, public health and recreational loss, among others. In estimating those costs, the study will engage stakeholders to help identify relevant datasets, records and cost considerations. Where necessary, the project team will develop groundwater models to simulate long-term contaminant spread. Using the insights gained from this analysis, the project team will develop a recommended framework to guide future decision-making for remedies at sites with groundwater contamination. The framework will supplement existing remedial action plans used by the State of Michigan's cleanup programs, incorporate the economic model and policy implications of long-term use of ICs, and evaluate the feasibility of alternative remediation actions.

A multi-disciplinary team of economists, policy analysts and water scientists will carry out this project. Assisting will be an advisory committee with expertise in groundwater management, stakeholder engagement, groundwater modeling and policy to provide guidance on the project's design and progress. EGLE will be an active partner, helping identify priority case study sites, facilitating access to state databases for environmental management and providing input on the development of the decision framework.

The project's primary outcome will be advice to EGLE on economic impacts that should be considered in the difficult decisions that need to be made about the long-term costs and effectiveness of groundwater contamination remedies. The project will also culminate in recommendations for policy and program changes.

The results of the project will help state and local decision-makers better understand the effects of current management strategies for contaminated groundwater and inform and improve decision-making about future uses of institutional controls. Funding for this project is provided by EGLE's Office of the Great Lakes through the Michigan Great Lakes Protection Fund. ◆

*Sampling at a Geoprobe location on the Scott Fetzer site in Bronson, Mich. Note sheen on surface of water in the bucket. Groundwater also smelled of diesel fuel. (Photo courtesy of EGLE)*

*Contaminated groundwater migrating across the surface of a treatment wetland. (Photo courtesy of EGLE)*

*Flow of contaminated groundwater migrating across wetland fill and vegetation towards open water. (Photo courtesy of EGLE)*

# Q&A WITH EGLE'S NEW MPART EXECUTIVE DIRECTOR

*Primary focus is on protecting public health, looking for new sources of PFAS contamination to groundwater*

*Abigail Hendershott became executive director of the Michigan PFAS Action Response Team in March 2021, after leading the state's largest PFAS contamination response to date – the investigation into the former Wolverine Worldwide tannery in Rockford. She provides an update in this Q&A.*

## The Michigan PFAS Action Response Team (MPART) has been at the national forefront in dealing with PFAS in drinking water. What has MPART done to sample for drinking water supplies that rely on the Great Lakes?

In 2018, MPART began sampling public drinking water supplies throughout the state, including supplies that use surface waters – streams and lakes including the Great Lakes – for their water. In 2019, six monthly samples were taken at public water supplies that use surface waters as a source of drinking water. Any anomalies found during the sampling effort resulted in more frequent and rigorous sampling. For 2021, these supplies have been sampled every other month, with this sampling continuing through the end of the year. Results from all sampling efforts are on the MPART website on the Drinking Water tab, Statewide Testing Initiative.

## How is MPART working with other Great Lakes states and provinces to address this issue on a regional and binational scale?

EGLE is participating in the Great Lakes PFAS Task Force, which is a multi-state collaborative effort to share information about PFAS and what states are doing to address PFAS in various media. There are three groups that are part of the Great Lakes PFAS Task Force: Group 1 involves state environmental directors; Group 2 involves state operations managers; and Group 3 consists of several topical workgroups. Within this task force, topics such as foam, air, water and site investigations are discussed at several levels in state governments and Ontario.

## What actions has MPART taken to reduce PFAS in Great Lakes waters?

As of August 2, 2021, EGLE had identified over 175 sites where groundwater is contaminated with PFAS at levels exceeding groundwater cleanup criteria. Some of these sites discharge to inland surface waters that connect to the Great Lakes. EGLE has established water quality standards for PFOS and PFOA used to regulate sources of PFAS discharging to surface water, including industrial sources, wastewater treatment plants, storm water discharges and contaminated groundwater discharging to surface waters. EGLE implemented an Industrial Pretreatment Program PFAS Initiative in 2018 to reduce PFAS concentrations entering wastewater treatment plants and passing through to biosolids.

## What's next in the effort to address PFAS in Michigan?

MPART's primary focus will continue to be on protecting public health and looking for new sources of PFAS contamination to groundwater. Ongoing surface water and fish sampling will be conducted throughout the state to study the occurrence of PFAS; data is used to track down potential sources of PFAS. As new PFAS contaminated sites are discovered, MPART will work with partners to evaluate health risks to nearby residential wells and provide filters or alternative water when necessary. Monitoring public drinking water supplies will continue by tracking compliance monitoring under the State Drinking Water Act. More specialized projects will include initiating a second round of firefighting foam pickup and disposal, developing a PFAS training video for firefighters, prioritizing fire training areas that are on private wells and sampling medium priority landfills. ◆


*Brandon Armstrong and Mike McCauley, EGLE, preparing Polar Organic Chemical Integrated samplers. These consist of metal discs with membranes, which are put inside metal cages and secured in a stream. (Photo courtesy of EGLE)*

*Brandon Armstrong and Mike McCauley, EGLE, putting the Polar Organic Chemical Integrated samplers into a locked cage. The cage with the sampler is put into the river for 28 days. (Photo courtesy of EGLE)*

*The Polar Organic Chemical Integrated sampler discs up close. The white membrane in each disc is what "captures" the PFAS. The membranes are sent to the lab for analysis after 28 days in the river. (Photo courtesy of EGLE)*

# THE GREAT LAKES WATER QUALITY AGREEMENT *at 50*

***Celebrating successes and recognizing what still needs to be done***

*By Lana Pollack*


*Great Lakes seen from space. (Photo courtesy of U.S. Environmental Protection Agency)*

Fifty years ago, facing public demands for environmental reforms, President Richard Nixon and Canadian Prime Minister Pierre Trudeau signed the first Great Lakes Water Quality Agreement (GLWQA or Agreement), bringing the weight of their offices together to address a single issue – excessive algae in Lake Erie. That Agreement, like the three iterations that followed, had no enforcement mechanisms. Instead, the Agreements relied on recognition by both governments that protecting and cleaning up the Great Lakes would require binational collaboration, and that each country – plus the states and provinces that bounded the five Great Lakes – would have to pass and enforce laws to ensure desired outcomes. Sometimes this expectation was met; often it was not.

Early success in addressing Lake Erie algae problems under the 1972 Agreement followed when the State of Michigan and other Great Lakes jurisdictions passed legislation to control phosphorous. The first Agreement also prompted both countries and their subnational governments to make major investments in upgrading municipal wastewater treatment plants. This visible success and the persistence of other obvious pollution problems prompted public support for stronger Great Lakes protections and motivated the two countries to sign another Agreement in 1978.

*Sleeping Bear Dunes National Lakeshore. (Photo courtesy of Michigan Sea Grant); (Above-right) Great Lakes Water Quality Agreement, 2012. (Image courtesy of binational.net)*

This second Agreement set more ambitious goals – to rid the Great Lakes of persistent toxic substances. With only nascent environmental bureaucracies in either country, Canada and the United States opened a joint Great Lakes office in Windsor, Ontario, and substantially increased support for the International Joint Commission (IJC), which had been established without enforcement powers to address U.S.- Canada boundary waters issues under the Boundary Waters Treaty of 1909. These additional resources supported the IJC's new responsibility to convene binational meetings and report every two years on progress achieved under the goals of the 1972 and 1978 agreements.

In the third Agreement, signed in 1987, Canada and the United States designated 43 of the Great Lakes' most polluted spots as Areas of Concern (AOC) and committed to cleaning them up. Although these massively expensive AOC cleanups were delayed for years due to lack of funding, in the last decade both countries ramped up their investments through programs like the Great Lakes Restoration Initiative, engaged tribal governments and community stakeholders and restored several AOCs to create vibrant waterfronts and public recreational spaces. While only nine of the 43 AOCs have been removed completely from the list, progress has been made on many other AOCs. Finishing the remaining cleanups will require billions of dollars and is likely to take at least 20 more years. Another notable success of the third Agreement resulted from the challenge to make Lake Superior a "Zero Discharge" demonstration zone, targeting elimination of nine pollutants over 20 years and leading especially to substantial mercury and dioxins reductions.

After a 17-year period when both countries built their environmental bureaucracies and shrank investments in IJC's binational activities, Canada and the United States signed a fourth GLWQA protocol. The 2012 GLWQA includes climate change concerns; reiterates the "obligation not to pollute boundary waters;" and keeps previous commitments to restore and maintain the Great Lakes' chemical, physical and biological integrity.

Organized around 10 subject area annexes, the latest Agreement promotes enhanced binational collaboration on specific Great Lakes challenges. In one example of early success prompted in part by the latest Agreement, both parties agreed to ban the production and sale of personal care products containing plastic microbeads, one of several significant sources of plastics in the Great Lakes.

Unfortunately, however, the current protocol eliminated previous Agreement lists of hundreds of hazardous polluting and potentially polluting substances. This has created challenges for designating and setting standards for protection against harmful chemicals, including the now designated "chemicals of mutual concern."

So, while we celebrate the Agreement's 50th anniversary with a mature system of binational cooperation and recognition of its positive outcomes for the Great Lakes, we also recognize threats old and new. These include legacy contaminants, PFAS, and other "forever chemicals," climate change impacts, invasive species, agriculture and other non-point source pollution – challenges that often fall hardest on underprivileged communities, communities of color and indigenous people.

More than anything, this birthday can best be celebrated with calls for both countries – as well as the states and provinces that bound the Great Lakes – to avoid further costly damages to Great Lakes waters by passing and enforcing the polluter pay and product life-cycle laws essential to realizing the Agreements' most important promises. ◆

*Lana Pollack has spent her life as a leader on environmental issues. After serving three terms in the Michigan State Senate, she became president of the Michigan Environmental Council, and in 2010, President Obama appointed her as chair of the U.S. section of the International Joint Commission. Here, she provides a look back at the Great Lakes Water Quality Agreement.*

# A retrospective on the AOC program after spending 30+ years in the program

***Program is an example of how large-scale, regional ecosystem restoration can be accomplished***

*By Kathy Evans, environmental program manager, West Michigan Shoreline Regional Development Commission*

Michigan's Areas of Concern (AOC) program was established with a "remedial" approach for the restoration of its Great Lakes toxic hot spots or "Areas of Concern." Remedial Action Plans were developed to identify the status of environmental problems and related Beneficial Use Impairents in each of Michigan's 14 AOCs. Over the years, Michigan's program has evolved as a shining example of how large-scale, regional, ecosystem restoration can be accomplished through community-based planning, contaminated sediment cleanups, and habitat restoration in some of the Great Lakes most severely degraded, environmentally complex water bodies.

During the 1990s, the AOC program was fragmented and there was a need to establish stronger local, state and federal partnerships to advance progress. During the early 2000s, Michigan's Public Advisory Councils (PAC) began establishing science-based targets and criteria for the removal of Beneficial Use Impairments (BUI). As this work evolved, the State of Michigan developed statewide guidance for several BUIs, greatly speeding up the process. The program is now well-coordinated by EGLE, in collaboration with a strong coalition of local, state and federal partners. The people involved in Michigan's AOC program are among those who are the most dedicated to Great Lakes restoration. In Muskegon, and other AOC communities, the AOC program has brought together diverse stakeholders to implement ecosystem-based plans that address contaminated sediments, loss of fish and wildlife habitat, degraded water quality, beach closings, and many other BUIs.

The Great Lakes communities involved in the AOC program are fortunate, in that they can tackle a wide variety of environmental concerns, all under the umbrella of a single Remedial Action Plan (RAP). This ecosystem approach allows communities to be involved in an efficient, holistic planning process to address the most severe impairments in their AOC. It's a process that makes sense to local people. The Great Lakes Legacy Act and the Great Lakes Restoration Initiative have provided the support needed to tackle these complex environmental problems. In addition to the cleanup and restoration of AOCs, long-term ecosystem health for AOC communities also depends on regulatory programs, voluntary grant programs, and continued public involvement. The Muskegon Lake Watershed Partnership took full advantage of the RAP process, met monthly since 1993, developed strong partnerships and, on September 30, 2021, celebrated the completion of all management actions needed to remove Muskegon Lake from the list of Great Lakes AOCs. We are getting things done because everyone is on the same page.

The role of many PACs has been to advance the cleanup needed to bring a water body to a state that is "no more degraded than other water bodies not designated AOCs." Ultimately, Michigan's AOC program will delist all 14 of its original AOCs, with three already delisted. During the past few decades, many PACs have evolved to become part of established watershed groups or have become closely affiliated with an organization whose mission includes the improvement of water resources. The Muskegon Lake Watershed Partnership will continue to meet monthly, provide a place for partnership development, and be good stewards of Muskegon Lake's natural resources into the future, beyond the major milestone achievement of AOC delisting.

*Kathy Evans is the environmental program manager for the West Michigan Shoreline Regional Development Commission, based in Muskegon, Mich. She has spent more than 30 years working with the Michigan AOC program, with a particular focus on restoration of the Muskegon Lake AOC.*

*Heritage Landing, a festival grounds and park owned by the County of Muskegon located in the heart of downtown Muskegon before restoration. (Photo courtesy of West Michigan Shoreline Regional Development Commission)*

*Restored shoreline habitat site on Muskegon Lake at Heritage Landing. (Photo courtesy of West Michigan Shoreline Regional Development Commission)*

*(Above) Heritage Landing on Muskegon Lake in Muskegon, Mich. a few years after habitat restoration. (Photo courtesy of West Michigan Shoreline Regional Development Commission)*

# The state of knowledge on harmful algal blooms of cyanobacteria in the Great Lakes

## HABs a growing threat to human and ecological health

*By Michelle Selzer, Michigan Department of Environment, Great Lakes, and Energy*

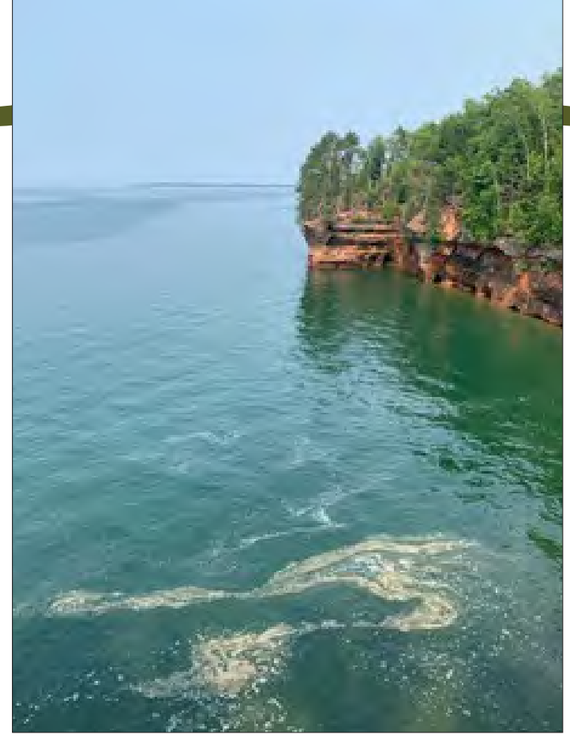
Harmful Algal Blooms (HABs) of cyanobacteria in freshwater systems like the Great Lakes are a growing threat to human and ecological health. The term HAB generally describes accumulations of cyanobacteria in amounts that are aesthetically unappealing and capable of producing algal toxins. While not all cyanobacteria produce toxins, significant blooms can still pose risks to human and ecosystem health.

Cyanobacteria, which live in both freshwater and saltwater environments, are among the oldest life forms on Earth. Since the mid-1990s, some waterbodies in the Great Lakes Basin have experienced an increase in the size, duration and frequency of toxic cyanobacteria HABs. In the case of the Western Basin of Lake Erie and Green Bay in Lake Michigan, these blooms can last all summer long. Beyond these well-known locations, HABs also occur in other areas, including Saginaw Bay and Georgian Bay (Canada) in Lake Huron; Sodus Bay (New York) and the Bay of Quinte (Canada) in Lake Ontario; the Canadian side of Lake St. Clair in the St. Clair-Detroit River System; and in Thunder Bay (Canada) and near the Apostle Islands (Wisconsin) in Lake Superior. HABs are also common phenomena, unfortunately, in many inland lakes and ponds, particularly those with developed shorelines and watersheds.

The presence of cyanobacteria blooms in Lake Superior in recent years has been a surprising development because the lake is a cold, nutrient-poor Great Lake, relative to the other lakes where HABs frequently occur. These conditions are considered limiting for cyanobacteria. Research on Lake Superior points to the role of severe storms that cause flooded rivers to supply unusually high pulses of nutrients to the lake. Rivers may also play a critical role in "seeding" areas of the lake with cyanobacteria that can form a bloom under the right conditions. Research is ongoing to better understand conditions that may facilitate the development of these unusual blooms in Lake Superior, including changes in light penetration, temperature fluctuations, shifts in nutrient concentrations, and dynamic internal and external nutrient loading sources to the lake.

The drivers of HAB occurrences in the Great Lakes Basin are complex and may or may not be synergistic depending on factors such as the trophic state (i.e., the amount of biological productivity) of the lake. Known drivers of HABs of cyanobacteria in the Great Lakes include changes in agricultural management practices in the watersheds, extreme weather events occurring in the spring and drought conditions in the summer. Increased air temperatures warm the lakes, especially in the shallow nearshore areas, and may cause reduced ice cover in the winter months. The invasion of zebra and quagga mussels has resulted in the trapping of nutrients closer to shore. These nearshore areas are also often prone to significant wave action and sediment resuspension, which can release accumulated nutrients from the sediment and further stimulate algal growth.

The Great Lakes scientific community anticipates that climate change will increase air and water temperatures as well as modify precipitation patterns leading to more frequent extreme weather events in the Great Lakes region. This may lead to more intense and widespread HABs of cyanobacteria, although warmer winters could also produce less snow and reduce the loads of nutrients that are carried down by rivers during spring snowmelt. The interaction of these complex environmental factors and the importance of increased nutrient availability continue to be areas of valuable research, especially under increasingly unpredictable future climate scenarios. In addition to climate change factors, the fishery managers in the Great Lakes are beginning to research the long-term biological impacts of mussels on nearshore eutrophication and offshore nutrient delivery that supports the food web and the primary productivity of the Great Lakes fishery.



*Minor algal bloom near the Mainland Sea Caves of the Apostle Islands, Lake Superior. (Photo courtesy of Stephanie Palmer)*

Although the understanding of HABs of cyanobacteria has increased considerably in recent years, additional ecological research and expanded environmental monitoring technologies are needed at different spatial and temporal scales to improve the understanding of climate change impacts and the role of internal and external nutrient sources fueling HAB occurrences in the Great Lakes. Expanding ecological forecasting, monitoring, and modeling for HABs across the lakes will also be critical to improve predictions of when and where HABs may occur, including their duration, severity, and toxicity. As our knowledge improves, this information can be used to inform binational, federal, state and local resource management decision-making to address controllable nutrient sources and better inform the public about risks associated with HABs. Managers are taking a more holistic and adaptive approach that is designed to incorporate new research and lessons that have been learned about the impacts of previous management actions. This will be a key in our Great Lakes community's ability to restore both the short- and long-term ecosystem health of the Great Lakes region and protect against future HAB occurrences in places like Lake Superior.

*(Above) Cyanobacteria bloom in July 2020 at Wenona Beach on Saginaw Bay, Lake Huron. (Photo courtesy of EGLE)*

# Coastal Wetlands

## ESSENTIAL TO THE HEALTH OF THE GREAT LAKES

***Great Lakes coastal wetlands are biological sanctuaries, unique and highly dynamic ecosystems and aesthetic marvels***

The Great Lakes are beloved by many people and are of an inherent significance to those who live in the region. Boaters, swimmers, hunters, anglers, artists, birdwatchers and people of all walks of life come to the shores of these lakes to add value to their lives in many ways. The coastal marshes, dune and swale complexes, Lakeplain prairies and fens that speckle the coasts of these wonderful lakes are havens for fish and wildlife, as well as for the many people who love to enjoy the serenity of these unique systems.

*A scene from black tern nest monitoring on Lake Michigan's Ogantz Bay in Delta County. In Michigan, black terns are species of special concern. In this photo, Joe Kaplan of Common Coast Research and Conservation looks for black tern nests. (Photo courtesy of Michigan Department of Natural Resources)*

## What is a Coastal Wetland?

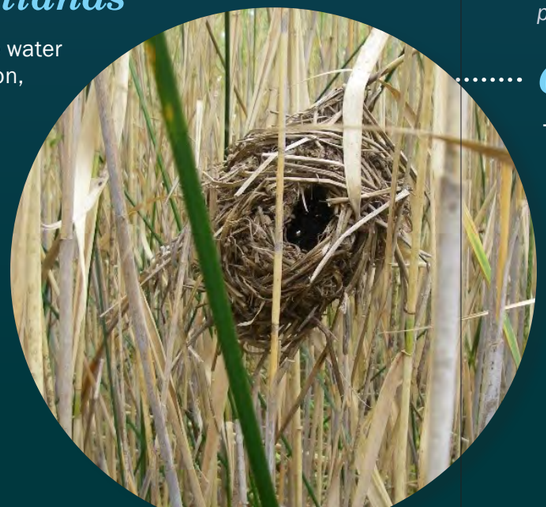
Wetlands are areas where water covers the soil or is present either at or near the surface of the soil all year or for varying periods of time during the year. Commonly referred to as bogs, swamps or marshes, wetlands support certain kinds of vegetation or aquatic life. Coastal wetlands, found throughout the shores of the Great Lakes region, are biological sanctuaries, unique and highly dynamic ecosystems and aesthetic marvels. They are essential to the health of the Great Lakes.

*Great Lakes coastal marsh, Lake Huron. (Photo courtesy of EGLE)*

## Benefits of Coastal Wetlands

Wetlands are considered valuable because they clean the water, recharge water supplies, reduce flood risks and provide fish and wildlife habitat. In addition, wetlands provide recreational opportunities, aesthetic benefits and commercial fishery benefits. Extremely biologically productive, they serve as spawning and nesting habitat for many of Michigan's fish, wildlife, migratory birds and waterfowl. Marsh and wetland vegetation anchors sandy shorelines during high water periods, protecting the shoreline from the erosive impacts of the waves and ice of the Great Lakes.

*Marsh Wren nest in a coastal wetland, Lake Huron. (Photo courtesy of EGLE)*





## How Coastal Wetlands change

Coastal wetlands are ever-changing, responding to changes in water levels, weather patterns and surrounding landscape impacts every year. Great Lakes water levels fluctuate as part of a natural cycle over time, and coastal wetlands respond to water level changes in many ways. During periods of higher water, many of the coastal wetlands transition into sparsely vegetated or submerged aquatic beds. During periods of lower water, many coastal wetlands transition into densely vegetated wet meadow and emergent communities, often expanding to cover the wide sections of exposed lake bottomlands.

## Threats to Coastal Wetlands

Threats to coastal wetlands include climate change, invasive species, shoreline hardening, development, nutrient and pollutant inputs from runoff and others. Despite their highly adaptable characteristics, the quality of coastal wetlands continues to be degraded because of these factors.

*Phragmites in St. John's Marsh, Mich. (Photo courtesy of Michigan Sea Grant)*

## Loss of Great Lakes Coastal Wetlands

Michigan has over 275,000 acres of Great Lakes coastal wetlands but has lost approximately 50% of the coastal wetlands that existed prior to European settlement. In some parts of the state, losses are as high as 90%.




*Graphic showing changes in extent of coastal wetlands over several years with changes in water levels, from the EGLE publication "Status and Trends of Michigan's Wetlands: Pre-European Settlement to 2005." (Figures courtesy of EGLE)*

## Great Lakes Coastal Wetland Monitoring Program

The Great Lakes Coastal Wetland Monitoring Program (CWMP) began in 2011 and is continuing a successful basin-wide Great Lakes coastal wetland monitoring program using a scientifically-validated sampling design for plants, invertebrates, fish, amphibians, birds and water quality. The CWMP is a long-standing partnership between 15 organizations throughout the Great Lakes basin, led by Central Michigan University and funded by the U.S. Environmental Protection Agency.

Field crews from the research organizations sample approximately 1,000 coastal wetlands every five years, providing a significant and continuous dataset for coastal wetland in a continuous time period. The results of this project are also used to inform planning and evaluation of wetland restoration projects throughout the Great Lakes region.

# Challenges and successes in managing invasive European frog-bit

*Aquatic plant spreading in coastal areas of Great Lakes*

*By Sarah LeSage and Kevin Walters, Michigan Department of Environment, Great Lakes, and Energy*

European frog-bit, an invasive aquatic plant on Michigan's Aquatic Invasive Species (AIS) Watch List, is spreading along Great Lakes' shorelines, connecting channels and inland waters. Recent Michigan detections include the lower Lincoln River in Mason County in 2021 and the Lower Grand River in Ottawa County and Pentwater Lake in Oceana County in 2019. European frog-bit was also found for the first time in Wisconsin in 2021, growing in an unnamed stream and throughout adjacent drainage ditches on the west shore of Green Bay.

European frog-bit was first detected in southeast Michigan in 1996 and has since spread along the coastal areas of Lakes Erie and Huron up to the eastern Upper Peninsula (U.P.), and now, recently, into multiple locations along Lake Michigan.

European frog-bit can form dense mats on the surface of slow-moving waters like bayous, backwaters and wetlands. These mats can impede boat traffic and alter food and habitat for ducks and fish. Because European frog-bit is free-floating, it can easily spread or be transported to new locations. European frog-bit also produces seeds and other seed-like structures called turions that may remain dormant for multiple seasons.

*European frog-bit with leaves, flower, and turions all shown. (Illustration courtesy of Bruce Kerr)*

Addressing the westward spread of European frog-bit is challenging due to how easily it can be spread through a variety of human pathways. Similar to other AIS, people play an important role in preventing the spread of aquatic invasive species in the Great Lakes region. Human activities like boating, waterfowl hunting and fishing can unintentionally spread the invasive plant because plant parts can attach to boats, trailers and gear.

Many of the bodies of water where European frog-bit is being found are popular destinations for angling, hunting and water recreation, which means there is a high potential to spread European frog-bit from these locations to other areas. Given that some of the most recent locations where European frog-bit is being found also have direct hydrologic connections to the Great Lakes, spread through the natural movement of water is also a concern.

Fortunately, there are some simple steps that boaters, anglers and waterfowl hunters can take to help prevent the spread of European frog-bit and other AIS. Signage, print materials and outreach campaigns such as billboards are helping to spread the message to "Clean, Drain, and Dry" any boats, trailers and other gear prior to use in another waterbody. Person-to-person messaging at boating access sites through the growth of Michigan's AIS Landing Blitz from a statewide event into the regional collaborative one is also focused on changing boater behaviors and preventing introduction and spread of many aquatic invasive species, including European frog-bit.



Michigan Department of Environment, Great Lakes, and Energy (EGLE) staff and partners collaboratively plan and undertake annual survey and response efforts across the state for European frog-bit along the Great Lakes coastal areas and on inland waters. The Upper Peninsula Resource Conservation and Development Council and all five U.P. Cooperative Invasive Species Management Areas (CISMAs) are working together to survey high risk areas across the entire U.P. and control known populations in the eastern U.P. Similarly, EGLE staff, contractors, CISMAs and other partners conduct surveys in the Lower Peninsula and use herbicides and hand pulling to prevent further spread. The Nature Conservancy, in partnership with the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service (USFWS), University of Toledo, Great Lakes Commission, Wayne State University and the Great Lakes states, created an early detection framework and interactive tool that determines risk of invasion from high-risk species at coastal locations across the Great Lakes Basin. This tool is used to identify locations for monitoring and is being expanded to inland waters.

*European frog-bit leaves. (Photo courtesy of EGLE)*

*European frog-bit forms dense mats that impede boat traffic and alter habitat. (Photo courtesy of EGLE)*

Research on European frog-bit is also being conducted to improve our understanding of this species and inform control efforts. Lake Superior State University, Central Michigan University, Michigan Natural Features Inventory, Loyola University and Boise State University, in collaboration with EGLE, CISMAs and other partners, are implementing projects to measure the efficacy of different control methods. They are evaluating the impacts of European frog-bit on native plants and animals as well as on water quality, investigating new detection methods, developing habitat suitability and risk models and understanding the life history of European frog-bit.

Outreach, surveillance, control and research efforts working in collaboration are essential to address the challenges presented by European frog-bit and other aquatic invasive species.

For more information about European frog-bit and other invasive species, visit Michigan's invasive species website. ◆

# **Connections matter:** *The importance and status of aquatic connectivity for fish in Michigan*

## *Restoring Great Lakes watersheds as a larger connected system*

*By Gary Whelan, Michigan Department of Natural Resources*

The Great Lakes are an amazing system that, like any other system, require connected component parts to function. In the Great Lakes case, its component parts are its many tributary watersheds. These watersheds are conduits for a range of materials from the landscape that feed the Great Lakes, including water, organic material, food for energy, sediment, nutrients, and woody debris.

To complete this critical function, a watershed's rivers and streams must be connected to each other and the Great Lakes. Each river and stream segment needs to be connected to its adjacent riparian area to efficiently feed materials to the Great Lakes.

The Great Lakes historically provided energy and nutrients back to the watersheds using fish as the primary mechanism but now accomplish this in a more limited way due to hydrologic systems being fragmented. Great Lakes watersheds depend on fish returning nutrients and energy back into tributary streams through adfluvial fish that live in lakes to maximize growth and spawn in rivers. Regardless of where fish live most of their lives – the Great Lakes or tributary streams – all fish need to move to complete their life history.

Stream fish move to find:

- the best feeding locations to maximize growth.
- cover to avoid predators.
- refuges to avoid harsh winter, drought and flooding conditions.
- the best spawning conditions.



*(Left) Sixth Street Dam, Grand Rapids, Mich., 2013. (Photo courtesy of Michigan Department of Natural Resources)*

These movements also ensure that fish can fully function throughout their life spans. This includes species that are:

- opportunistic and quickly colonize habitats and often have short life spans.
- nesting species with medium life spans and require the ability to move to spawning areas.
- adfluvial or potamodromous (use bigger streams and rivers to grow and spawn in smaller stream) species that can have life spans that range all lengths.
- late maturing, with periodic spawning that have very long lives.

Historically, Michigan's Great Lakes tributaries were full of fish from the Great Lakes, particularly in the spring, and in some cases today, they still are. Nearly every Great Lakes fish species had an adfluvial population – one where fish spawn in tributary streams where the young rear from 1 to 4 years before migrating to a lake system where they grow to maturity. When reproduction occurs in different areas, risk of reproductive failure is minimized and catastrophes avoided.

Native Americans took prime advantage of this readily available, early spring protein source. A study of the distribution of their villages clearly shows that they were often located on key spawning areas for adfluvial fish. There are many accounts from early European settlers of wagon full loads of suckers being taken from the Saginaw River and Grand River by early settlers.

Lake sturgeon were documented from many tributary streams with records indicating fish ran the Grand River to Eaton Rapids, the Menominee River to Sturgeon Falls, the Kalamazoo River to Albion, and the Tittabawassee River to Sanford. Even lake trout were documented in the St. Joseph River at Niles. Masses of fish moving upstream from the Great Lakes was likely staggering to see prior to dams, landscape scale logging, overharvest and water pollution.

Today, fragments of Great Lakes tributaries remain and only a few rivers and streams are fully connected, including the Ford, Two Hearted, Pere Marquette and Carp Rivers. Even with these fragments, the numbers of fish moving in the spring is large.

*Historic water quality fish passage barrier, Escanaba River, Delta County, Mich., Circa 1970. (Photo courtesy of Michigan Department of Natural Resources)*

*Perched culverts that are fish movement barriers, South Branch Pentwater River. (Photo courtesy of Michigan Department of Natural Resources)*

Michigan has approximately 72,000 miles of flowing water that is now highly fragmented. These waters have 2,400 dams listed in the Michigan Dam Database, and this list does not include all of the dams on our streams. Only a very small number (about 25) have any type of fish passage, and while fish passages at dams certainly helped move some fish past these barriers, they are a poor second choice. Dams disrupt the movement of sediment, woody debris, and organic matter from the landscape to the Great Lakes, storing these landscape outputs in their respective impoundments.

*Concrete flood channel, Lower River Rouge, Wayne County, Mich., 2002. (Photo courtesy of Michigan Department of Natural Resources)*

Additionally, there are more than 49,000 known road crossings of rivers and streams, of which, nearly 22,000 are culverts that likely block fish movement. Culverts also change the movement of the rest of the materials from the landscape until they clog and are washed out by extreme weather events. That causes even more resource damage. Dams and culverts create barriers to movement every 2.7 river and stream miles.

Fish movement is also impaired by river and stream channels that have been placed into concrete channels or have been channelized, which does not allow full fish movement. Finally, there are still some locations where water quality issues cause fish to avoid those river channels, acting much as a physical barrier.

The challenge is to correct this Great Lakes watershed impairment, and it is a huge issue. Assuming we could remove all unnecessary dams, install fully functional fishways at all other dams, correct all culvert issues, and replace all concrete channels, the total cost is estimated to be over $6 billion.

Fortunately, there is a large collective movement underway to consider our infrastructure's condition, its resilience in the face of a rapidly changing climate, and its effects on a broad range of ecosystem benefits.

Michigan is a leader in the removal of dams, inland fish passage, selective fish passage, and improving road-stream crossing to make them landscape friendly. Each year, the DNR works with many partners to remove unnecessary and often unsafe dams and to change round culverts to structures that span the streams, slowly reconnecting our remarkable aquatic heritage for future generations.

Some of the most recent successful fish passage and dam removal efforts to restore connectivity in Michigan river systems include: Ceresco Dam (Kalamazoo River); Lyons Dam (Grand River); the Boardman, Sabin and Brown Bridge Dams (Boardman River); Frankenmuth Dam (Cass River); Chesaning Dam (Shiawassee River); Sturgeon Dam (Sturgeon River – Dickinson County) and Salling and Stump Pond Dams (AuSable River). In addition to improved ecological health, many of these restored connections now also provide important opportunities for outdoor recreation along our waterways, which contribute to local economies and quality of life in communities across the state. ◆



# BRINGING BACK THE WHITEFISHES

***Renewed interest in key native fish is expected to lead to its revival***

*By Todd Wills, Edward Baker and Dave Clapp, Michigan Department of Natural Resources*

Great Lakes "coregonines" are an ecologically and economically important group of fishes within the trout and salmon family.

In Michigan, this group of fish in the genus Coregonus includes well-known species such as lake whitefish and cisco, as well as less-familiar fish such as shortjaw cisco, bloater and kiyi.

Historically, these widespread and abundant species supported large commercial fisheries, created recreational fishing opportunities and provided a critical link in Great Lakes food webs between plankton and top predators such as lake trout and walleye.

Unfortunately, by the middle of the 20th century a number of factors – including over-fishing, loss of habitat and predation and competition from invasive species such as sea lamprey and rainbow smelt – caused many Great Lakes coregonid populations to collapse. This group continues to host some of the most imperiled native species in the Great Lakes, and much interest exists in rehabilitating their populations.

Many of the same pressures that caused coregonid populations to decline in the past century still exist and remain a concern today. While lake whitefish continue to be a highly-desired food fish in the Great Lakes, their populations have exhibited slow growth and poor body condition that correlate with the loss of Diporeia, a group of zooplankton species that has been in decline since the invasion of zebra and quagga mussels in the late 1980s.

Further, lake whitefish populations have experienced poor recruitment since the early 2000s, which is thought to be due to climate variability and resulting changes in water temperature, water levels and currents and ice cover as well as pressure from zebra and quagga mussels that continue to alter zooplankton communities (and their availability as a food source for young fish) and foul spawning habitat. Great Lakes

*Cisco catch, midwater trawl, from Grand Traverse Bay, Lake Michigan. (Photo courtesy of DNR)*

*Implanting lake whitefish from Lake Michigan with acoustic tags. (Photo courtesy of DNR)*

cisco have experienced a loss of diversity and historical forms that bridged lower and upper trophic levels and are sending different population signals across the basin. Cisco populations are declining in Lake Superior, expanding in Lake Michigan and geographically isolated in Lake Huron despite opportunities to expand and fill an open niche in the food web.

These issues, combined with gaps in knowledge and information about environmental, behavioral and genetic factors that support existing coregonine fisheries, make fisheries management a challenge. To address these challenges, staff from state, federal and tribal natural resource agencies in Michigan are currently engaged in collaborative work, facilitated through the Great Lakes Fishery Commission's lake committee structure, to address knowledge gaps and advance coregonine management, as detailed in the accompanying infographic. ◆

# GREAT LAKES COREGONINE RESEARCH AND REHABILITATION UNDERWAY

*Collaboration is key to address knowledge gaps and advance native fish management*

Over-fishing. Loss of habitat. Invasive species. Changes in water temperature. All these issues – and more – make fisheries management a challenge in the Great Lakes for a group of fish called coregonines, which includes lake whitefish and cisco, also called lake herring.

Collaborative work is underway through the Great Lakes Fishery Commission's lake committees to conduct research and identify solutions.

## 1 LAKE SUPERIOR

The Lake Superior Technical Committee and its member agencies have been engaged in research to determine factors important in cisco recruitment dynamics. Cisco is an important commercial species in Lake Superior, but recruitment has been low and inconsistent in recent years. Agencies are engaged in lake whitefish acoustic telemetry work around the Buffalo Reef complex, an important lake whitefish spawning habitat threatened by encroaching stamp sands.

## 2 LAKE MICHIGAN

The lake-wide assessment plan (LWAP) is a collaborative effort across Lake Michigan resource agencies to improve consistency of data collection for both lake whitefish and cisco. For example, standardized seining surveys are conducted each year by agencies to index the abundance and growth of young-of-year cisco and lake whitefish.

Several shorter-term targeted research efforts have been initiated in recent years. Multiple investigations of nearshore zooplankton populations, larval emergence, growth and feeding patterns have been funded in recent years with interest in contrasting the two species. Controlled laboratory studies are also being conducted to further explore variation among the two species in foraging behaviors, preferences and vulnerability to predation. Unique to lake whitefish, river surveys have been conducted to evaluate whether there are river-spawning populations in Michigan. That will inform discussions about how to best incorporate river populations into management plans.

*Implanting lake whitefish from Leland Harbor in Lake Michigan with acoustic tags. (Photo courtesy of DNR)*


## 3 LAKE HURON

The Lake Huron Technical Committee is beginning an effort to review and implement its lake whitefish research priorities. It has embarked on a decade-long cisco reintroduction experiment and evaluation. Up to a million fingerling cisco are being stocked annually in the vicinity of outer Saginaw Bay using northern Lake Huron populations as source populations. These stockings are being assessed through existing fish community assessments, targeted sampling, and surveys of recreational and commercial fishers.

## 4 LAKE ERIE

While the habitat in western Lake Erie doesn't support coregonids year-round at this time, its tributaries, including the Detroit River, historically hosted some of the largest populations of coregonines in the Great Lakes through the 1920s. Remnant populations of lake whitefish still exist, and the system still provides important spawning habitat for lake whitefish. Substantial effort has gone into restoring reef spawning habitat that was lost to development in the past century.

*Monitoring midwater trawl depth and hydroacoustic targets during a survey in Saginaw Bay, Lake Huron. (Photo courtesy of DNR)*

*Lake whitefish. (Photo courtesy of DNR)*

This renewed interest in a group of key native fish is expected to pay dividends this decade with the revival of these remarkable fish. These efforts that are benefiting Michigan fish populations would be impossible without the efforts of many partners and funding through Sportfish Restoration and State Wildlife Grants from the U.S. Fish and Wildlife Service, along with Great Lakes Restoration Initiative funds from the U.S. Environmental Protection Agency.

These conservation dollars are matched by funds from Michigan's Game and Fish Protection Fund that is supported by fishing and hunting license sales. ◆

# DNR planning more green space, equity opportunities along Michigan waterways

## *Priority on projects that promote equity and environmental justice*

*By Alexis Hermiz and John Pepin, Michigan Department of Natural Resources*

The Michigan Department of Natural Resources (DNR) has an engagement priority to expand the diversity of its userbase and broaden diversity in its workforce. Michigan has a diverse population, representing many racial, ethnic and cultural backgrounds, and the work the department does to uphold the public trust should be done through an equity lens.

The DNR understands that everyone does not have the same level of resources and access to a healthy environment and quality recreation. Knowing this, the DNR is committed to engaging in intentional projects that promote equity and environmental justice.

The DNR's land use strategy highlights the need to engage with partners in urban areas in southeast Michigan to understand their connections, interests and understanding of public land access. The department also noted the importance of increasing the diversity in stakeholders offering feedback and public comment.

With the upcoming revision of its Statewide Comprehensive Outdoor Recreation Plan, the DNR is working to include a diversity of stakeholders, particularly more communities of color and residents of urban areas, to provide feedback on recreation in Michigan.

The DNR is engaged in several efforts aimed at providing more opportunities for green space, equity, recreation and environmental enhancement along Michigan waterways.

One project will be the first of its kind in Michigan, creating a wetland in support of a multi-state and Canadian effort to combat algal blooms in the Western Lake Erie Basin.

Michigan's efforts will align with Ohio's successful H2Ohio project, which is a comprehensive water quality initiative working to strategically address serious water issues that have been building in that state for decades, including harmful algal blooms on Lake Erie caused by runoff from farm fertilizer.



*(Left) People walking along the Detroit River Walk. (Photo courtesy of DNR)*

The Michigan project site has yet to be determined, but it will be located within the Upper Maumee River watershed and the River Raisin watershed in southeast Michigan. This project aligns funding from the Michigan Natural Resources Trust Fund and the federal Great Lakes Restoration Initiative for the DNR to acquire land to be developed into a functional wetland complex, which would filter phosphorus and other contaminants prior to reaching Lake Erie.

Once acquired by the DNR, the property would be a state game area providing habitat, resource and recreational opportunities, in addition to the goals of the phosphorus and containment filtering that would take place on-site. It will also help meet equity goals of the DNR in providing more access to recreation opportunities in the southeast part of the state.

Meanwhile, the DNR continues concerted efforts to contribute to the ongoing larger multi-stakeholder efforts to redevelop and revitalize the Detroit River waterfront. To date, the DNR has contributed close to $60 million to improvements, as well as operating its Outdoor Adventure Center, Milliken State Park and Belle Isle.

Construction started in the fall on the Ralph C. Wilson Centennial Jr. Park on land owned by the DNR, leased to the Detroit Riverfront Conservancy, and funded primarily by the Wilson Foundation. When completed, the park should be on the same scale (activities, programmed spaces, uniqueness) as Millennium Park in Chicago or Central Park in New York City.

These projects help beautify the riverfront area, add important greenspace and provide increased and enhanced opportunities for fishing, biking, hiking, wildlife viewing and more.

The Michigan DNR has a diversity, equity, inclusion and justice officer on staff to help provide guidance to the department on projects that promote the department's equity and inclusion work. The officer's role is to help the DNR operationalize equity in everything it does and ensure it is working to provide access to quality and safe recreation for all visitors.

*Rendering of aerial view of Ralph C. Wilson Centennial Jr. Park in Detroit, Mich. (Rendering courtesy of Detroit Riverfront Conservancy)*

# Working to support coastal communities: Resilient Michigan Collaborative offers new community sustainability tool

***Tool helps communities prioritize best practices to promote sustainability and resilience***

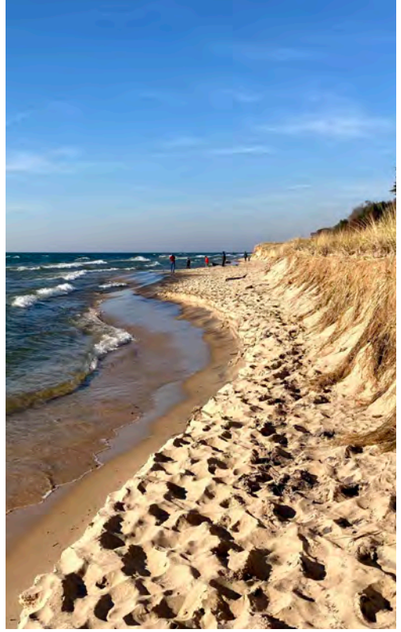
*By Ronda Wuycheck, Michigan Department of Environment, Great Lakes, and Energy and Matt Cowall, Land Information Access Association*

Michigan's Great Lakes coastal communities benefit from some of the most beautiful natural settings in the world. But coastal communities also face unique and complex challenges that are inherent to ever-changing shoreline conditions. The Resilient Michigan Collaborative (RMC) is a partnership between the Michigan Coastal Management Program (MCMP) and the nonprofit Land Information Access Association (LIAA) to help coastal communities become more resilient to the dynamic conditions that come with living, working and playing on the shores of the Great Lakes.

The recent record-high water levels on the Great Lakes starkly contrast a not-so-distant past of record lows that were recorded a mere seven years earlier. The natural cycling of lake levels is a prime example of the need for adaptability in coastal communities, which is best achieved by doing resiliency planning in advance. A coastal community can proactively prepare itself to adapt to changes in Great Lakes water levels, coastal storms and floods; manage social and environmental changes and build a better and more reliable local economy that is less susceptible to changes and shocks to the system.

In 2021, the RMC, through funding provided by the MCMP and LIAA, began providing matching mini grants to interested coastal communities to analyze local master plans and zoning ordinances using a Community Sustainability Assessment Tool. The tool helps communities think about and prioritize best practices to promote sustainability and resilience. The tool is divided into four main community systems: economic, social, coastal hazards and environmental. In total, there are 39 sustainability topics with 254 benchmarks. Once the benchmarks – and any gaps – are analyzed, communities have the information they need to take proactive steps toward increased resilience. These steps may include an update to the community Master Plan in its entirety or the addition of a chapter focused on resilience.

*Lake Michigan coastal storm. (Photo courtesy of Michigan Sea Grant)*



*Lake Michigan shoreline. (Photo courtesy of Michigan Sea Grant)*

Since its inception in 2019, the RMC has worked with more than a dozen communities, ranging across the state from South Haven, Norton Shores and Emmet County on the west side to Fort Gratiot Township and the Southeast Michigan Council of Governments on the east side. More communities can get involved by visiting the Resilient Michigan website. A webinar was hosted in June 2021 and provides further background on the RMC. ◆

## SHORELINE EROSION, HIGHWATERS TOP COMMUNITY CONCERNS

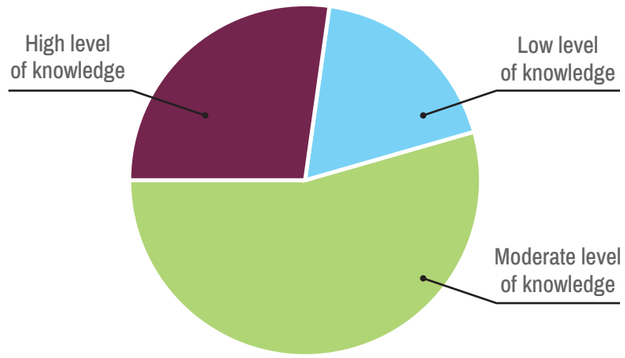
In 2021, the Great Lakes and St. Lawrence Cities Initiative, a coalition of more than 130 U.S. and Canadian mayors and local officials of the Great Lakes and St. Lawrence region, surveyed municipal entities in the region about coastal issues.

The Coastal Resilience Needs Survey gathered information to better understand the context in which local communities are responding to and planning for coastal resilience challenges. Almost 300 respondents took the survey, 94 of them located in Michigan, representing cities, townships, villages, tribal governments, counties and other local government entities.

The survey showed a high degree or moderate degree of concern (96.2%) from municipalities over their coastal issues. Respondents cited shoreline erosion and flooding/high waters as the most concerning issues. Despite the level of concern over coastal issues, only a quarter of respondents considered their staff to be highly knowledgeable in the topic. The survey also explored other related topics including funding levels, infrastructure, resiliency planning and communication with the public.

A summary of the Great Lakes and St. Lawrence Cities Initiative's survey findings is available on the organization's website. A full report including the survey results is expected to be released in early 2022.

**Rate the general level of knowledge the staff in your jurisdiction have regarding coastal issues**




*(Data courtesy of Great Lakes and St. Lawrence Cities Initiative)*

# WATER-ENERGY NEXUS AND NEW INITIATIVES TO DRIVE WATER AND ENERGY SAVINGS

## *Research shows measurable savings for residents and utilities*

*By Jake Wilkinson, Michigan Department of Environment, Great Lakes, and Energy*

Water and energy are inextricably linked in the drinking water and wastewater systems of a community. Broadly speaking, wastewater plants and drinking water systems can account for up to one-third of a municipality's total energy bill. Drinking water systems use energy to extract water at its source, transmit it to treatment facilities, treat it to satisfy safe drinking water standards and pump it through the distribution system to end users. Wastewater utilities use energy to pump, treat and discharge treated wastewater.

Many service lines in drinking water systems leak and often go undiscovered for long periods of time because they are upstream of the customer meter. These leaks are also a loss in potential revenue to drinking water utilities because the utility does not earn revenue from leaks that are upstream from the meter.

The American Water Works Association states that the average reported service line leak is 6.9 gallons per minute at 70 pounds of pressure per square inch (psi). Although their leakage rates are low, the annual volume of hidden leakage losses usually far exceeds the water lost in catastrophic, visible main break events. Average overall water loss in drinking water systems has also been estimated at 16%, with up to 75% of that being recoverable. Based on the inventory of service lines in Michigan, which includes the rated useful lives of those service

*Blue polybutylene water service pipe (manufactured between 1978-1995) failure. Steel stiffeners at compression joints are typically where failures occur. (Photo courtesy of Ottawa County Road Commission)*

lines and leakage rates, it is estimated that service line leaks result in over 21.5 billion gallons of water wasted per year statewide. Research has also found that municipal drinking water systems have a combined use of over 52 million kilowatt-hours (kWh) of electricity per year – enough to power almost 5,000 homes for an entire year.

EGLE's Energy Services is focusing on a series of projects to address this water-energy nexus in drinking water and wastewater systems, building upon previous successful programs. The Water-Energy Nexus project led by the Michigan Municipal Association for Utility Issues (MAUI) was created to quantify the energy used to treat and pump drinking water to end users in the drinking water distribution system. The purpose of the Water-Energy Nexus project is to assess how much energy is wasted in the distribution of water that leaks from water service lines in Michigan and to determine how much energy could be saved if service line leaks were reduced. The project focuses on leaks in service lines, which run from the water main to the end user.

Another project underway by EGLE is the Water Leak Pilot Program, which was designed to repair water leaks in the communities of Highland Park and Benton Harbor. Targeting 100 homes in each community, the program is focused on reducing a home's water use through the repair of leaking pipes and replacement of old, inefficient fixtures. Initial data has shown in Highland Park that half of homes with completed repairs have reduced residents' water consumption by 50% or more. Water reductions in the homes will save not only water but also energy. Hot water loss reduction will reduce the homeowner's energy costs, and cold-water loss reductions will save energy for the municipal system in line with the findings of the Water-Energy Nexus project. Project work is still ongoing but has been well-received by the communities and lessons learned can be expanded to other communities across the state.

EGLE sponsored Fix a Leak Week in March 2021 to address plumbing and water system leaks in residential homes. This event focused on:

- Sharing educational materials about the importance of repairing water leaks.
- Developing a directory of water conservation and plumbing repair resources available to Michigan residents.
- Engaging with partners to develop policy and funding recommendations to support water leak repair efforts in disadvantaged communities.

EGLE has also signed onto the U.S. Department of Energy's Sustainable Wastewater Infrastructure of the Future (SWIFt) 2.0 accelerator program, which will result in using less energy to process water – reducing both the cost to process water and its carbon footprint. SWIFt Phase 2 (SWIFt 2.0) will continue the momentum of the Phase 1 pilot program by leveraging the tools, resources and lessons to benefit the broader wastewater sector. EGLE will assist in facility engagement and peer exchange forums, as well as assisting participating facilities in the development of an infrastructure improvement plan. These efforts will help wastewater facilities by connecting them to energy management best practices. In addition, wastewater utilities will receive technical assistance to support planning for strategic infrastructure upgrades that incorporate energy efficiency measures and contribute toward reducing the amount of energy needed to process the wastewater.

These programs all address the significant energy consumption embodied in the treatment of and distribution of water for customer use as well as treatment of water collected by sewer systems in Michigan. These programs can help reduce the substantial costs associated with water systems in a community and help communities on their path to carbon neutrality and water stewardship. ◆

## HIDDEN LEAKS MORE THAN WATER LOST IN MAIN BREAKS

### *2021 Water and Energy Waste Projections from Service Lines (SL) Leaks in Michigan*

The table below shows the calculated leaks and embodied energy waste for service lines (SL) in Michigan.

| | Known & Likely Lead SLs | Other SLs | UBL* | Total | Units |
|---|---|---|---|---|---|
| # of SL leaks | 5,656 | 33,270 | n/a | 38,926 | count |
| Volume of SL leaks | 1,686,015,297 | 9,917,123,056 | 9,947,432,687 | 21,550,571,040 | gallons/year |
| Embodied Energy waste | 4,097,017 | 24,098,609 | 24,172,261 | 52,367,887 | KWh |

** UBL = unavoidable background leaks*

# WATER TECHNOLOGY

## TO TACKLE CLIMATE, ENERGY AND MOBILITY CHALLENGES IN THE GREAT LAKES

***Focus is on solving existing and future Great Lakes challenges***

*By Travis White, Michigan Technological University, Great Lakes Research Center*

The Great Lakes have seen many recent stressors, including high water levels, high wave energy, harmful algal blooms, invasive species, hypoxia and others.

The lakes, however, still present an enormous opportunity for the region in terms of climate resilience, access to clean fresh water, a strong and growing blue economy, workforce development and technology research and development.

The Great Lakes Research Center (GLRC) at Michigan Technological University focuses on using these opportunities to help solve existing and future challenges in the Great Lakes.

The GLRC combines hydrodynamic modeling, high resolution autonomous bathymetry, and buoys to observe and predict the short- and long-term impacts of high water levels. The GLRC is also working toward creating smart and autonomous maritime systems to improve mobility on the lakes and improve safety for mariners. The Smart Ships Coalition (SSC), housed at GLRC and supported by the Marine Autonomy Research Site (MARS), brings industry, government and academia together to help develop technology, safety protocols and policy surrounding the incorporation of autonomous maritime systems into the mobility solutions of tomorrow.

Through partnerships with the Michigan Economic Development Corporation's (MEDC) Office of Future Mobility and Electrification and the Mackinac Economic Alliance, the GLRC is investigating electrification of the Mackinac Island ferries and the potential to power these electric ferries with clean renewable energy from the region.

In addition to technology development and scientific research, Michigan Tech also brings strong workforce development to the Great Lakes. The GLRC develops undergraduate and graduate level scientists and engineers ready to tackle upcoming challenges. An emerging emphasis is on a cyber-ready workforce with skills in data science, machine learning, artificial intelligence, cybersecurity and autonomous marine systems. Through a partnership with the MEDC, the GLRC and SSC will host the inaugural Cyber Boat challenge, a hackathon challenge for college students focusing on maritime cybersecurity. These skills will position Michigan's future mobility workforce as the world's premier mobility workforce.

In the fall of 2021, with support from the Department of Environment, Great Lakes, and Energy's Office of the Great Lakes, the SSC and GLRC convened a number of events in Michigan, bringing together leaders from the SSC and across the maritime mobility ecosystem to initiate projects in the areas of workforce preparation, technology development and applications and policy development through participant-driven working groups.

The goals of this effort will be to help the industry implement solutions to common challenges to continue advancing the Great Lakes region as a national leader in the maritime domain. Goals also include sustaining the momentum of the prior investment and efforts to develop the SSC and MARS through strong multi-sector participant engagement.

Through these collaborations, the GLRC and Michigan Tech continue to tackle the challenge of solving difficult problems for the Great Lakes region and are positioning the state of Michigan to be a key player in the Blue Economy, while preserving the state's natural resources for generations to come.

*(Top left) Scientists deploy a remotely operated vehicle (ROV) through the ice in front of Michigan Tech's Great Lakes Research Center to capture images of the bottom surface of the ice. (Photo courtesy of Michigan Technological University); (Top right) Researchers deploy Michigan Tech's Autonomous Underwater Vehicle (AUV) IVER 3 in the Keweenaw Waterway to take a closer look at an unmarked shipwreck. (Photo courtesy of Michigan Technological University)*

# Thank you.

Many thanks to the experts, contributors, partners, writers and editors who contributed their time and efforts to this 2021 State of the Great Lakes Report. The stories reflect the dedication this past year of our region's natural resource stewards and community voices within our state who all share a passion for Michigan's Great Lakes water resources. The views and opinions expressed within this publication are those of the individual authors and do not necessarily reflect the official policy or position of the Michigan Department of Environment, Great Lakes, and Energy, the Office of the Great Lakes, or their partners.

Gretchen Whitmer, Governor

Liesl Eichler Clark, Director, EGLE

**This report is available digitally at the Michigan Office of the Great Lakes webpage, *Michigan.gov/OGL***



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